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Policy Review
Climate Change Policy and Subjective Well-Being

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ABSTRACT
A small (but increasing) number of economists has recently started to recognize that the costs of climate change mitigation measured as reduced growth in GDP need not reduce welfare in view of the weak correlation between the two in richer economies, *provided* that mitigation and employment policies are properly combined. In this paper we sketch neglected links between these – now major – research areas and discuss how subjective well-being and employment could be raised in the medium term by cost-effective mitigation and green fiscal policy, in addition to the long-run benefits of greenhouse gas reductions. A 'green new deal' placing more emphasis on climate change mitigation and happiness (rather than GDP as the key proxy for welfare) could be the appropriate strategy in the current economic climate of austerity and worsening recession, while also initiating the large-scale mitigation investment for job creation that is so urgently needed. Copyright © 2012 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

WHILE SEARCHING FOR A SUCCESSOR TO THE KYOTO PROTOCOL, A STRING OF INCONCLUSIVE UN CLIMATE Conferences has agreed on the importance of limiting global mean temperature to 2 °C above pre-industrial levels, but failed to agree on more concrete policies. The latest in Durban in late 2011 did achieve unanimity – but only on delaying action until 2020. At the same time the potential for *extreme* climate change and its consequences is receiving greater attention in scientific and popular discourse and several papers have been discussing both the actual geophysical processes that can lead to catastrophic climate change and the social vulnerabilities involved (Travis, 2010). The latest science points to much faster climate change than originally thought, due to 'slow' but accelerating feedbacks such as thawing permafrost and receding Arctic ice and snow cover with potentially significant consequences for already-fragile agriculture and food supply, particularly in the developing countries (Hansen and Sato, 2011; O'Connor *et al.*, 2010; Lenton *et al.*, 2008). Several scholars have cast serious doubt on how such consequences, including large-scale loss of life, can be adequately captured by GDP losses for a *given* future population (see van den Bergh, 2004, as well as Weitzman, 2007, for a discussion of the sensitivity of climate cost–benefit analysis to the value of statistical life). Neumayer (2007) emphasizes that the high risks to the poorest

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populations take us beyond the scope of valuing statistical lives according to 'willingness to pay' (since any kind of 'insurance' is far beyond the means of those most affected), and into the realm of redistributive and intergenerational ethics.

Substantial mitigation could be achieved by major investment in energy saving, green transport, and conservation agriculture: investment that also yields positive financial returns in the short term from fossil fuel savings, reduced health damage from local pollution, and employment benefits from 'green fiscal policy', particularly during the current economic recession. However, to approach what is increasingly recognized as the maximum scientifically 'safe' atmospheric CO_2 level of 350 ppm, from the current 393 ppm, a rapid global switch from fossil-fuel to alternative, low-carbon energy is also required (Delucchi and Jacobson, 2011; Hansen and Sato, 2011; Hansen *et al.*, 2008). Cost–benefit analysis, though, often presents *drastic* mitigation as too costly in terms of slower future GDP growth, and hence favours much less ambitious targets (Stern, 2008, 2009), based on worst-case estimates of 'climate catastrophe' as a 20% reduction of a much *higher* future GDP.[1]

Recent work by Speth (2008), Jackson (2009), FitzRoy and Papyrakis (2010) and most rigorously by van den Bergh (2009a, 2009b) discusses several flaws in the cost–benefit analysis of climate change (in particular the issue of evaluating policies on mitigation as well as climate impacts exclusively in monetary terms and percentages of GDP, which is assumed to continue growing indefinitely). This approach pays little attention to more than 30 years of research on happiness and its determinants, which finds no significant correlation between *long-term* or trend growth of GDP and changes in average happiness or subjective well-being (SWB) in richer economies (i.e. the 'Easterlin paradox', due to Easterlin, 1974).

van den Bergh (2009a) explains why recent findings on the key determinants of SWB and the Easterlin paradox need to inform ongoing research on climate change economics and policy. He concludes

> First, although climate policy may lead to a slower pace of economic growth... this translates into a smaller or even insignificant loss in happiness terms, depending on which country or group of people is considered. Secondly, climate policy aimed at preventing extreme events implies avoidance of serious reductions in happiness, given that happiness directly depends on climate.... Third... for people in poor countries it may mean that their basic needs will come under threat....

We emphasize that, as a consequence of the long-standing reliance on GDP as a welfare indicator, economists tend to underestimate the potential of climate change mitigation to *raise* SWB, even when GDP growth may slow down. Our main contribution is to emphasize the more immediate, *positive* effects of mitigation on happiness and to argue that green fiscal policy and labour-intensive green technology have the potential to reduce both unemployment and emissions and stimulate growth in the current recession (though perhaps with slower GDP growth in the long run). The plan of the paper is to briefly survey recent insights from happiness studies and highlight relevant positive links between appropriate mitigation and real welfare (following section). In the next section we explain how a 'green new deal' could be an appropriate response in the current economic downturn, stimulating employment, curbing future emissions and raising SWB. We discuss conservation agriculture and the new initiative by the Transport, Health and Environment Pan-European Programme (of the United Nations Economic Commission for Europe and the World Health Organization) on 'Green and Healthy Transport Jobs' as policy examples. We summarize conclusions in the fourth section.

Subjective Well-Being and Climate Policy

Much empirical work shows that money does indeed 'buy happiness', though at a decreasing rate, across countries and individuals: i.e. there is a concave, positive association between SWB proxies and GDP per capita or household income in multi-variable, cross-sectional regressions or panel data regressions with individual fixed effects.[2] Why is

[1]Nordhaus (2008) has typically used higher discount rates in his CBA analysis, which further reduce the present value and relative importance of future climate damage in favour of more modest carbon taxes with less impact on emissions.

[2]See Brown *et al.*, 2008; Frijters *et al.*, 2004; Hagerty and Veenhoven, 2003; Kahneman and Deaton, 2010; Luttmer, 2005; McBride, 2001; Stevenson and Wolfers, 2008. There are also studies that confirm with the use of instrumental variables (i.e. industry wage differentials; see Li *et al.*, 2011; Pischke, 2011) that this is the correct causal relationship (although there is also a handful of studies that suggest reverse causality; see Diener *et al.*, 2002; Proto and Sgroi, 2009).

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it then that we observe essentially no correlation between *long-run* average income growth and improvements in average happiness in rich countries? The solution to this puzzle lies partly in the fact that happiness does not depend on the absolute income level alone (Clark *et al.*, 2008; Frey, 2008; Howarth, 2003, Luttmer, 2005, Layard *et al.*, 2010, Layard, 2011). *Relative* (or comparison) income also plays a very important role, and individuals tend to evaluate their current economic situations in comparison to the situations of others (social comparison), and with respect to their own in the past (adaptation). Happiness h_{it} of an individual i at time t will hence depend both on own income y_{it}, a reference income level with respect to another group of peers y^*_{it}, a reference income level with respect to own income in the past $y_{i(t-1)}$ and a vector of other socio-economic characteristics Z (e.g. leisure, social capital, environmental/health attributes etc). This is summarized in the generic happiness specification below, of which several variants have been tested in recent empirical studies (see Clark *et al.*, 2008 for an overview).

$$h_{it} = \alpha_1 \ln(y_{it}) + \alpha_2 \ln\left(y_{it}/y^*_{it}\right) + \alpha_3 \ln\left(y_{it}/y_{i(t-1)}\right) + \alpha_4 Z \tag{1}$$

(where coefficients are expected to be positive for the first three regressors), or equivalently

$$h_{it} = \left(\alpha_1 + \alpha_2 + \alpha_3\right) \ln(y_{it}) - \alpha_2 \ln\left(y^*_{it}\right) - \alpha_3 \ln\left(y_{i(t-1)}\right) + \alpha_4 Z. \tag{2}$$

Equations (1) and (2) show that, while our own income matters, external and internal reference points (own past income, average income of other reference groups) are also influential in determining happiness. The status return from having higher income with respect to a reference group (see α_2 of Equation (1)) has little impact on country-level happiness over time (higher status of any individual i results in lower status for anyone else in the economy – 'status is in effect a zero-sum game' (Clark *et al.*, 2008, p. 101). The adaptation impact (see α_3 of Equation (1)) captures the fact that any positive happiness effects of increases in income tend to fade away over time – i.e., there is a negative happiness externality due to habituation).[3] Equations (1) and (2) reveal that, when α_1 is sufficiently small, happiness depends mainly on relative income (with respect to a reference group or own past income) and other socio-economic characteristics Z. If status has little aggregate impact on country-level happiness and rising average income levels have mainly transient effects on happiness due to adaptation and cyclical effects, one would expect only a weak correlation between *long-run* income growth and happiness change. A number of studies suggest that the effects of absolute and comparison income are statistically of similar magnitude and opposite sign (see, e.g., Clark and Oswald, 1996; Clark, 1999, Ferrer-i-Carbonell, 2005; Grund and Sliwka, 2007; Helliwell and Huang, 2005). In any given year, richer countries on average are happier than poor countries, but happiness differences *between* the richer countries are mainly caused by institutional variations in democracy and corruption, and differences in other socio-economic characteristics (captured by Z, as well as the social comparison and adaptation effects, as shown in detail by Altindag and Xu, 2011).[4] Since GDP growth is often correlated with declining social capital in various forms, there is an additional negative externality that helps to explain the rather flat relationship between income levels and happiness over time for richer economies (Bartolini *et al.*, 2009; Bartolini and Sarracino, 2011).

Some confusion has been caused by cyclical effects. Short-term fluctuations in GDP are of course accompanied by changes in unemployment, and job-loss is itself a major cause of unhappiness, in addition to the resulting decline in income (Di Tella *et al.*, 2003). The absolute effect of income losses is greater than that of income gains of similar magnitude (Burchardt, 2005; Kahneman and Tversky, 1984). Burchardt (2005) also provides evidence that adaptation to past income can be asymmetric: people adapt more readily to rising rather than falling income levels. Expectations of future income also fall in recession and rise in recovery, so there is a strong positive correlation between cyclical, or short-run, changes in average GDP and happiness. As Layard *et al.* (2010) and Easterlin and Angelescu (2009)

[3]The internal reference point may include past history as well as aspirations for the future. A sudden increase in status and income, say from promotion to a better job, raises happiness, but also generates a new reference group relevant for the new position and tends to raise aspirations accordingly. Layard *et al.* (2010) find that the adaptation effect is much smaller than the effect of comparison income, which is of similar magnitude but opposite sign to own income.

[4]Additionally, at any point in time, there is a much stronger correlation between individual/household income and happiness within a country due to the comparison income effect.

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have shown in detail, it is essential to remove these cyclical effects from time series in order to estimate the effect of long-run, *trend growth* on happiness. Stevenson and Wolfers (2008) include the short-run effects in their analysis of growth, which naturally dominate the weak trend effects, and leads to the erroneous conclusion that long-run growth always increases SWB.

Many authors confirm that social capital (captured by crime, divorce rates, social trust, community, friendship) and environmental and health attributes are important determinants of happiness that need to be included in the vector Z of Equation (1). Differences in these socio-economic/environmental characteristics are often sufficient to offset to a large degree the positive impacts of income growth on SWB. Di Tella and MacCulloch (2008, p. 29), for example, find that doubling the mean divorce rates and sulphur oxide emissions would offset the positive effect attributed to a 28% and 39% increase in absolute income, respectively. These are impacts of significant magnitude, which are also verified by numerous other studies (e.g. Brereton *et al.*, 2008; Frey *et al.*, 2009; Luechinger, 2009; Moro *et al.*, 2008; Powdthavee, 2008; Welsch, 2002, 2006; Zimmermann and Easterlin, 2006). There is also growing evidence that material, or GDP growth, particularly under growing income inequality, erodes many components of social capital and thus SWB, in addition to the better-known environmental externalities (Bartolini *et al.*, 2009; Bartolini and Sarracino, 2011).[5]

While economic progress has brought great advances to global health and nutrition, the degradation of the planet's life support systems associated with anthropogenic pressures, particularly those activities contributing to climate change, pose serious risks to future human health, food security and well-being (McMichael and Beaglehole, 2000; Schlenker and Lobell, 2010). For example, fossil-fuelled growth tends to have substantial health impacts through air and water pollution in many developing countries, where rapidly growing urban traffic and coal or biomass burning contribute to high levels of indoor and outdoor pollution (Chan and Yao, 2008; Hoskins, 2011).[6] In big cities everywhere, 'car addiction' not only contributes significantly to global CO_2 emissions but is also a major cause of local urban pollution, premature mortality, and morbidity (Douglas *et al.*, 2011; Roberts, 2010). Climate change is also expected to impact on human health in areas close to the tropics by facilitating the spread of infectious diseases in populations already vulnerable due to malnutrition and lack of clean water (Béguin *et al.*, 2011; Ostfeld, 2009). The capability for healthy life, productive work and indeed survival is strongly linked to food (and water) security, which will be increasingly at risk for many densely populated countries (see Schlenker and Lobell, 2010; Schlenker and Roberts, 2008).

Following a long, critical tradition, van den Bergh (2009a, 2009b) and Stiglitz *et al.* (2010) discuss in detail the shortcomings of GDP as a proxy for social welfare (failure to account for negative externalities, imperfect substitutability of its components, exclusion of the informal economy, omission of the most important determinants of SWB), as well as the weaknesses of cost–benefit analysis (e.g. appropriate use of discount rates, valuation of intangibles, probabilities of extreme climate change) to account for welfare impacts of climate change and its mitigation options. Cost–benefit analysis, thus, often exaggerates the cost of *drastic* mitigation in terms of slower future GDP growth, and favours weaker targets (Nordhaus, 2008). Subjective well-being could better inform effective climate mitigation policies by taking into account the often neglected links between mitigation, income growth and the determinants of happiness.

These ideas are just beginning to enter political discourse, with an 'All Party Parliamentary Group on Well-being Economics' in the UK since 2009, a similar group in Germany, and collection of regional data on life-satisfaction to complement traditional economic statistics. While still a long way from influencing policy, all this suggests that slower and greener growth, that minimizes social and environmental externalities, has the potential to actually *raise* most people's SWB, and to prevent climate change damage, which reduces SWB and may be catastrophic in the longer term.

The study of happiness is one of the most rapidly growing fields of economics and psychology and there is much scope to refine happiness measurements in various dimensions and hence provide better guidance for policy interventions. There is, for instance, some evidence that individuals may use different 'response scales' and benchmarks when they self-assess their relative positions. Some empirical papers have made use of the 'anchoring vignettes' methodology (where individuals are asked to evaluate, on the same scale on which they evaluate

[5]Brockmann *et al.* (2009) and Easterlin and Angelescu (2009) provide similar evidence on some of the fastest growing developing economies such as China and Chile, which have actually experienced declining SWB.

[6]In a recent paper, Epstein *et al.* (2011) estimate that the pollution costs of coal, in terms of direct damage to health and environment, exceed the market price of coal-generated power ('accounting for the many external costs over the life cycle for coal-derived electricity conservatively doubles to triples the price of coal per kWh of electricity generated'.

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themselves, the level of life satisfaction of one or more hypothetical persons) in order to correct for response scales (e.g. Kapteyn *et al.*, 2007; Kristensen and Johansson, 2008). More recently, it has been shown that variations in response scales may also influence differences and relative ranking in self-reported life satisfaction across countries (see Angelini *et al.*, 2011; Kapteyn *et al.*, 2010).[7] In spite of these issues, the main results of SWB research appear to be robust, particularly with individual data for any one country, and correlate well with many objective indicators, including evidence from neuroscience (Layard, 2011). In the same vein, policy-makers and statistical agencies should place more emphasis on greener national accounts that correct GDP for negative externalities (e.g. environmental and health impacts).

It should also be emphasized that CBA has an important role to play in microeconomic analysis, in the choice of the most financially cost-effective technologies for mitigation and adaptation. At the more macro level, climate change CBA suffers from several complexities linked to uncertainty (e.g. with respect to the dynamic pattern of climate and nature of effects) and the challenges with appropriate valuation of impacts. At the micro level, CBA has advanced considerably, allowing policy-makers to prioritize interventions – Watkiss *et al.* (2009) for instance suggest that CBA can be used to set climate change adaptation priorities in the public sector, when the costs and benefits of alternative options are well defined. Furthermore, life satisfaction surveys can provide monetary estimates for intangibles (e.g. health/environmental attributes), which could then be used in cost–benefit analysis or to 'green' the standard national accounts. The life satisfaction approach can provide more accurate monetary estimates of externalities than hedonic pricing and contingent valuation methods, for instance when pricing does not fully reflect differences in preferences or interviewees follow a strategic response behaviour (van Praag and Baarsma, 2005).[8]

A Green New Deal

There remains the widely perceived problem that *transition* to a slower growth path, if fossil fuels were to be rapidly phased out in a major mitigation effort, would cause significant economic disruption and declining welfare. Traditionally, job-loss and growing unemployment (an important determinant of unhappiness) have coincided with periods of growth slowdown and SWB declines (although this only captures short-term cyclical relationships between GDP and SWB rather than any long-term trends; Layard *et al.*, 2010). Economists generally agree that taxing carbon or tradable emissions permits (if they are auctioned rather than given out for free) could guide the transition to sustainable, clean energy (as well as removing the huge global subsidies for fossil fuels, which the International Energy Agency (IEA, 2010) estimates at around $400 billion). Some of the revenue from carbon taxes could be used to reduce taxes on labour, which would expand employment, and lower welfare expenditure. Shifting the tax burden from labour towards carbon-intensive activities may lead to declining tax revenue, as aggregate carbon emissions start to fall, but this could be counterbalanced by the effect of increased employment (Schöb, 2005). The net effect on public revenues will naturally depend on the corresponding elasticities (of employment and emissions with respect to tax), but governments could compensate for any fall in public revenues by higher taxes on economic activities with negative health/environmental externalities.

Since the beginning of the financial crisis in late 2008, persistently high unemployment and stagnation in most industrial countries has strengthened opposition to any new carbon taxes (and diverted attention from the urgency of emission reduction), in spite of their potential to stimulate employment by financing 'green' jobs. The science points to large risks from delaying transition to a low carbon economy, and we have argued that slower but greener growth is more likely to raise SWB than traditional policies with all their environmentally and socially destructive externalities. Of course, a precondition for this is the restoration and maintenance of full employment along the path of restructuring our carbon dependent economies (as well as breaking the historical link between slowdowns in GDP growth and rising unemployment). As repeatedly emphasized by Nobel Prize winning economist Paul Krugman (2008) and other

[7]Linking self-reported happiness with objective physiological and neurological characteristics or having a third party (family members, friends) to validate replies can also improve reliability (see Diener and Lucas, 1999; Urry *et al.*, 2004).
[8]Monetary estimates based on life satisfaction questionnaires have been obtained, for instance, for airport noise nuisance (van Praag and Baarsma, 2005), flood hazards (Luechinger and Raschky, 2009) and air quality (Luechinger, 2009).

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Keynesians, a fiscal stimulus is urgently needed in the current economic downturn and 'liquidity trap' of almost zero interest rates (combined with very low *core* inflation), instead of the austerity measures for which most policy-makers have so far opted (and which are likely to further slow the economy and exacerbate unemployment, as has happened in similar historical episodes). The favoured policy response of 'quantitative easing', or creating money to buy government bonds, mainly pushes up asset prices and encourages commodity speculation (which has helped to drive headline inflation after the recession, though commodity prices started to decline again in May 2011), with only small effects on employment or aggregate demand (Krugman, 2008, 2009, 2012).[9]

Additional public expenditure could be funded directly by monetary expansion (with limited risk of igniting core inflation when the economy is so far below capacity) and raising employment both directly, and indirectly through the multiplier. In particular, investments in energy saving and alternative energy could be initiated by individual countries as an anti-recessionary, 'Green New Deal' or fiscal policy, without waiting for international political agreement on the ultimately necessary carbon taxes, but with immediate benefits or 'triple dividends' of lower unemployment and emissions, and a dramatic rise in the happiness of the newly employed – and of the many others whose fear of job-loss would recede in a more optimistic environment (NEF, 2009; Tsai 2009; Stiglitz, 2010).[10] Maintaining full employment during the large structural changes required for transition to low carbon will involve much greater government activity in the economy, including higher taxation. Nordic European social democracy offers the most successful example, which has provided prosperity for most with much less inequality, less exposure to the global financial crisis, high marginal tax rates and the top international rankings for SWB and most indicators of social welfare, as well as exemplary environmental policy (Wilkinson and Pickett, 2009). Denmark, for example, with few other natural resources, has been a pioneer in wind power and policies to promote employment flexibility, combined with government-subsidized retraining and re-employment for job-losers (Mathiesen *et al.*, 2011).

The construction sector has generally been one of the worst affected by declining employment in the current recession (Davies, 2011; Drudy and Collins, 2011). At the same time, buildings use about 40% of total energy, while insulation and energy efficiency in most older buildings are far below best available standards. Renovation and retrofitting insulation and efficient energy equipment is labour intensive, so there is significant potential for gains in employment with investment in mitigation in this sector. Energy saving investment will obviously become more financially profitable in the medium term if fossil fuel prices continue to rise as expected (Haug, 2011; Weiss and Bonvillian, 2009). Already, modern wind turbines in good locations can be cost competitive with conventional sources, in addition to their positive environmental/employment effects, though modern 'smart grid' connections are also needed (Traber and Kemfert, 2011). Similarly, solar power cost has also been falling dramatically as technologies mature (Fthenakis *et al.*, 2009; Deichmann *et al.*, 2011). These technologies, in combination with major energy saving, could cost-effectively replace fossil fuels globally by mid-century, according to comprehensive analysis by Jacobson and Delucchi (2011).

Green fiscal and climate policies will naturally create both winners and losers in terms of employment. Jobs will be lost in fossil fuel sectors, but more are likely to be generated in the greener and more labour-intensive, climate-friendly ones. There is already evidence that climate policies have the potential for (net) job creation. Fankhauser *et al.* (2008), for example, provide a review of labour intensity estimates showing much higher labour intensity (on average) in the renewable energy sector compared to the fossil-energy sector. The number of jobs per megawatt ratio, for instance, is in the range of 7.41–10.56 and 0.71–2.79 for solar and wind energy, while only 1.01 and 0.95 for coal and gas respectively. A recent study by Houser and Heilmayr (2009) also suggests that a green stimulus package in the US during the current financial crisis could create four times more jobs than the equivalent amount of a tax rebate. There is also evidence from input–output analyses suggesting that the net employment impact of climate policies (e.g. carbon trading, setting transport and building standards) is positive (Bailie *et al.*, 2001; Krause *et al.*, 2003). Although further research (e.g. in the form of computable general equilibrium models, see Küster *et al.*, 2007) will help to estimate the net employment effect of different climate policy interventions, the

[9]Krugman also regularly discusses these issues in his *New York Times* column, as well as frequently updated blog: http://krugman.blogs.nytimes.com

[10]A labour-intensive fiscal stimulus is also likely to reduce poverty-driven crime (another determinant of unhappiness) and hence provide additional welfare gains (Di Tella and MacCulloch, 2008).

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evidence so far suggests that green investment has the potential to simultaneously foster employment and reduce emissions, particularly in the current crisis of persistently high unemployment.

Given that climate change is expected to mainly affect the poorest in the developing world, a global switch to a low-carbon economy is needed to protect their future generations from catastrophic droughts, floods and heat-waves. These countries face the most challenging problems: their current need to grow out of extreme poverty, combined with the greatest long-term threat from climate change, in particular to their already vulnerable agriculture. Their solar and other alternative energy resources offer huge, but largely unexploited, potential for green growth and sustainability for the wider population, in the face of threats from worsening water shortages and climate change. Halting tropical deforestation and investing in conservation and sustainable harvesting would involve short-term costs, but could also create large financial and climatic benefits in the long run for the countries concerned as well as the rest of the world: not least in terms of the currently threatened biodiversity's potential for medical and scientific advances.

Another major contribution to emission reduction, as well as to food security and employment, could be made by switching from high-input and vulnerable industrial agriculture to more labour-intensive and resilient conservation agriculture. Labour-saving technologies of industrial agriculture substitute imported inputs for local jobs, displacing farmers, and hence exacerbating the major problem of un- and under-employment in developing countries (Foley *et al.*, 2011). Furthermore, the high yields of the green revolution were achieved with rapidly growing inputs of energy, chemicals and water, as well as high-yielding varieties and monocultures, but these methods are becoming increasingly costly as fossil fuel prices rise and water shortages worsen (Horlings and Marsden, 2011). Soil erosion increases as organic matter declines and extreme weather becomes more frequent, and together with urban and road development destroys global farmland (Flora, 2010; Montgomery, 2008). Much of this is being made up by tropical deforestation and destruction of savannah for cultivation, which in turn has devastating effects on local environments. Even without climate change, these factors represent serious threats to food security, but rising temperatures and probabilities of more frequent, major droughts *interact* with these trends to increase the likelihood of potentially catastrophic famine in the not too distant future (Cribb, 2010; Eccleston, 2009; Hanjra and Qureshi, 2010). Temperatures over 30 degrees during the growing season generally reduce grain yields by around 10% for each extra degree, and hitherto record droughts and heat-waves such as in Europe in 2003 and Russia in 2010, which reduced harvests by 30–40%, could be a recurring phenomenon by mid-century (Foley *et al.*, 2011).

Alternative conservation agriculture is defined by the Food and Agriculture Organization of the United Nations (FAO) as follows: 'Conservation agriculture (CA) aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations'. Niggli *et al.* (2009) review the evidence on these and related issues, showing that leguminous cover crops with minimum tillage can fix nitrogen and improve soil quality and resistance to extreme weather by increasing organic matter, raising yields and dramatically reducing chemical, energy and water input costs. These methods are adaptable to local conditions and small-scale farming in developing as well as rich countries, as many successful projects have shown (Sayre and Govaerts, 2011). At the same time, extensive carbon sequestration through accumulating organic matter in soils could reverse the opposite effects of industrial agriculture and make a major contribution to both mitigation and food security (Lal, 2011; Thierfelder and Wall, 2010). In addition, there are large potential employment and welfare benefits in developing countries, from reversing the flow of displaced rural populations to growing urban slums – often the victims of subsidized exports from developed economies, vested interests of agri-business multinational corporations and labour-saving industrial agriculture. All these interests directly oppose the establishment of conservation agriculture suited to local environments and needs, which could increase yields sustainably with higher rural employment (Albritton, 2009; LaSalle and Hepperly, 2008; Montgomery, 2008; Stiglitz, 2006).

Conservation agriculture as part of a green new deal can also offer major benefits to industrial economies, where rural depopulation and environmental pollution under labour-saving industrial agriculture are serious problems in many areas (Wezel *et al.*, 2009; Zaferatos, 2011). The heat-waves of 2003 in Europe and 2010 in Russia revealed the vulnerability of large-scale, industrial monocultures. Conservation methods in mixed farming, which also help to reduce emissions, could be more resilient to such extremes (Kassam *et al.*, 2009; Venkateswarlu and Shanker, 2012). Furthermore, food and, in particular, meat prices do not reflect the negative external costs of factory farming, including the imported feed that often encourages deforestation and destruction of savannah in developing country

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suppliers. A rise in market prices and smaller-scale meat production can complement sustainable mixed farming, with beneficial effects for the environment and rural employment (Fairlie, 2010; Hudson, 2005).

Aid to developing nations to finance such a transition to conservation agriculture and alternative energy could reduce global carbon emissions, as well as raise income and welfare, and reduce the flight of displaced rural populations to the urban slums, but still remains far below what is needed (Neumayer, 2007; Sachs, 2011). Conservation agriculture would thus benefit both the current poor and, through greater food security and reduced emissions, the future poor, who are most threatened by unsustainable industrial agriculture and climate change.[11]

Finally, a new initiative by the Transport, Health and Environment Pan-European Programme (THE PEP of the United Nations Economic Commission for Europe and the World Health Organization) on 'Green and Healthy Transport Jobs' can be perceived as a concrete step in the direction of boosting green employment, lowering emissions and pollution and raising well-being. THE PEP was originally established in 2002 to develop transport in an environmentally friendly, healthy and economically viable way. In 2011 the programme launched an ambitious initiative in order to 'bring together interested member states, experts and policy-makers from the transport, environment and health sectors and develop a set of actions and joint projects aiming at (a) documenting the breadth of existing experiences in Europe and elsewhere with new policies for creating green and healthy jobs in transport, (b) analysing the potential of greening old jobs and assessing the qualitative and quantitative impact of such approaches on the environment and the economy and (c) developing strategies and actions for stakeholders in order to support such job creation (WHO, 2011).

THE PEP has defined green and healthy transport jobs as those that are contributing to not only climate change mitigation and broader environmental improvement, but also health, well-being and equity. Investment in green and healthy jobs in the transport sector has a multifold impact directly on its users; i.e., walking and cycling reduces carbon emissions and pollution (air and noise), increases physical activity and complements public transport. Furthermore, transport is globally a key sector of the economy, and in the European Union (EU) alone transport provides an estimated 16 million jobs. THE PEP has been working to 'reframe' the role of transport in society, in particular through 'green' transport and the opportunities it presents to improve the environment, but also contribute to better quality of life, particularly among rural or disadvantaged households, who may have been traditionally marginalized from public transportation and unable to afford private transport.

In making the transport sector 'greener' and healthier, jobs can be created by the construction and maintenance of public transport vehicles and infrastructure, the operation and upkeep of public transport systems, bike hire and car-sharing schemes, as well as renewable energy technologies for electric and other lower carbon vehicles, among many other benefits, both direct and indirect. There are many opportunities not only for the creation of additional jobs, but also for adapting existing jobs to cater to a greener transport sector. In Austria, for example, a national programme for green and healthy transport jobs in public transport is expected to create 15 000 green jobs through the expansion of public transport, electric mobility and cycling. Already 200 000 Austrians work in the economically vital and growing environmental sector and the government's goal is to create 100 000 additional green jobs by 2020.

Conclusions

In this paper, we have discussed key insights from recent research on happiness and its determinants and described the *positive* linkages that can arise between appropriate climate change mitigation and well-being. There has been remarkable progress on the scientific foundations of well-being and happiness and on the necessity of cost-effective mitigation investment in order to avoid negative effects of climate change. The challenge is now to combine these two approaches, both at the micro and at the macro policy level, and identify relevant links that have been neglected.

[11]Some projects (as in the case of conservation agriculture) have the potential to both pursue poverty alleviation and mitigate climate change. For other types of activity this complementarity of objectives may not be possible. Michaelowa and Michaelowa (2007) discuss how diverting Overseas Development Assistance away from (non-environment) poverty alleviation projects towards climate change mitigation/adaptation may hamper poverty reduction and improvements in SWB for the current generation in developing economies. When this is the case, ideally one should aim for an additionality of climate change related aid in relation to poverty reduction relevant aid, but there is very little research on whether this has indeed been the case.

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While a few economists and others have made a start, climate change policy-thinking needs to incorporate much more from growing research on SWB.[12]

In this vein, we argue that a 'green new deal' based on a green fiscal stimulus (and a shift of the tax burden from labour towards carbon-intensive activities) would be an ideal policy response in the current economic downturn, simultaneously stimulating employment, redistributing income and curbing future emissions in the transition to slower, sustainable growth and low carbon economies, as well as augmenting the positive determinants of happiness. In addition to such complementarities, urgent climate mitigation can prevent changes in environmental conditions in the medium to long term with potentially devastating impacts on living conditions and SWB, particularly for the poorest populations. Such impacts are often misrepresented when debates focus on GDP growth trajectories alone. Economic policy needs to abandon GDP growth as its ultimate objective, and incorporate the linkages between environmental quality, social networks and happiness – much of which amounts to changing the way we value and measure progress (van den Bergh, 2009b).

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References

Albritton R. 2009. *Let Them Eat Junk*. Pluto: London.

Altindag DT, Xu J. 2011. The Impact of Institutions and Development on Happiness, Working Paper AUWP 2011–08, Department of Economics, Auburn University.

Angelini V, Cavapozzi D, Corazzini L, Paccagnell O. 2011. Do Danes and Italians Rate Life Satisfaction in the Same Way? Using Vignettes to Correct for Individual-Specific Scale Biases, Working Paper 11/20, Health, Econometrics and Data Group, University of York.

Bailie A, Bernow S, Dougherty W, Lazarus M, Kartha S, Goldberg M. 2001. *Clean Energy: Jobs for America's Future*. World Wildlife Fund–Tellus Institute–MRG & Associates: Boston, MA.

Bartolini S, Bilancini E, Sarracino F. 2009. Sociability Predicts Happiness: World-Wide Evidence from Time Series, Working Paper 579, Department of Economics, University of Sienna.

Bartolini S, Sarracino F. 2011. Happy for How Long? How Social Capital and GDP relate to Happiness over Time, Working Paper 621, Department of Economics, University of Sienna.

Béguin A, Hales S, Rocklöv J, Louis VR, Sauerborn R. 2011. The opposing effects of climate change and socio-economic development on the global distribution of malaria. *Global Environmental Change* **21**: 1209–1214.

Brereton F, Clinch JP, Ferreira S. 2008. Happiness, geography and the environment. *Ecological Economics* **65**: 386–396.

Brockmann H, Delhey J, Welzel C, Yuan H. 2009. The China puzzle: falling happiness in a rising economy. *Journal of Happiness Studies* **10**: 387–405.

Brown GDA, Gardner J, Oswald AJ, Qian J. 2008. Does wage rank affect employees' wellbeing? *Industrial Relations* **47**: 355–389.

Burchardt T. 2005. Are one man's rags another man's riches? Identifying adaptive expectations using panel data. *Social Indicators Research* **74**: 57–102.

Chan CK, Yao X. 2008. Air pollution in mega cities in China. *Atmospheric Environment* **42**: 1–42.

Clark AE. 1999. Are wages habit-forming? Evidence from micro data. *Journal of Economic Behavior and Organization* **39**: 179–200.

Clark, AE, Frijters P, Shields MA. 2008. Relative income, happiness, and utility: an explanation for the Easterlin Paradox and other puzzles. *Journal of Economic Literature* **46**: 95–144.

Clark AE, Oswald AJ. 1996. Satisfaction and comparison income. *Journal of Public Economics* **98**: 359–381.

Cribb JHJ. 2010. *The Coming Famine: the Global Food Crisis and What We Can Do to Avoid it*. University of California Press: Berkeley, CA.

Davies S. 2011. Regional resilience in the 2008–2010 downturn: comparative evidence from European countries. *Regions, Economy and Society* **4**: 369–382.

[12]See Eriksson and Andersson (2010) and van den Bergh (2009a), and environmentalists such as McKibben (2007), Speth (2008), Jackson (2009) and Hamilton (2010).

DOI: 10.1002/eet

Deichmann U, Meisner C, Wheeler D. 2011. The economics of renewable energy expansion in rural Sub-Saharan Africa. *Energy Policy* **39**: 215–227.
Delucchi MA, Jacobson MZ. 2011. Providing all global energy with wind, water, and solar power, Part II: Reliability, system and transmission costs, and policies. *Energy Policy* **39**: 1170–1190.
Di Tella R, MacCulloch R. 2008. Gross national happiness as an answer to the Easterlin Paradox? *Journal of Development Economics* **86**: 22–42.
Di Tella R, MacCulloch R, Oswald AJ. 2003. The macroeconomics of happiness. *The Review of Economics and Statistics* **85**: 793–809.
Diener E, Lucas RE. 1999. Personality and subjective well-being. In *Well-Being: the Foundations of Hedonic Psychology*, Kahneman E, Diener E, Schwarz N (eds). Sage: London; 213–229.
Diener E, Nickerson C, Lucas RE, Sandvik E. 2002. Dispositional affect and job outcomes. *Social Indicators Research* **59**: 229–259.
Douglas MJ, Watkins SJ, Gorman DR, Higgings M. 2011. Are cars the new tobacco? *Journal of Public Health* **33**: 160–169.
Drudy PJ, Collins ML. 2011. Ireland: from boom to austerity. *Regions, Economy and Society* **4**: 339–354.
Easterlin RA. 1974. Does economic growth improve the human lot? In *Nations and Households in Economic Growth: Essays in Honour of Moses Abramowitz*, David PA, Reder MW (eds). Academic: New York; 89–125.
Easterlin RA, Angelescu L. 2009. Happiness and Growth the World Over: Time Series Evidence on the Happiness–Income Paradox, IZA Discussion Paper 4060.
Eccleston CH. 2009. Peak food? *Environmental Quality Management* **18**: 9–17.
Eriksson R, Andersson J. 2010. *Elements of Ecological Economics*. Routledge: London.
Epstein PR, Buonocore JJ, Eckerle K, Hendryx M, Stout BM, Heinberg R, Clapp RW, May B, Reinhart NL, Ahern MM, Doshi SK, Glustrom L. 2011. Full cost accounting for the life cycle of coal in 'Ecological Economics Reviews'. *Annals of the New York Academy of Sciences* **1219**: 73–98.
Fairlie S. 2010. *Meat: a Benign Extravagance*. Permanent: East Meon, Hampshire, UK.
Fankhauser S, Sehlleier F, Stern N. 2008. Climate change, innovation and jobs. *Climate Policy* **8**: 421–429.
Ferrer-i-Carbonell A. 2005. Income and well-being: an empirical analysis of the comparison income effect. *Journal of Public Economics* **89**: 997–1019.
FitzRoy F, Papyrakis E. 2010. *An Introduction to Climate Change Economics and Policy*. Earthscan: London.
Flora CB. 2010. Food security in the context of energy and resource depletion: sustainable agriculture in developing countries. *Renewable Agriculture and Food Systems* **25**: 118–128.
Foley JA, Ramankutty N, Brauman KA, Cassidy ES, Gerber JS, Johnston M, Mueller ND, O'Connell C, Ray DK, West PC, Balzer C, Bennett EM, Carpenter SR, Hill J, Monfreda C, Polasky S, Rockström J, Sheehan J, Siebert S, Tilman D, Zaks DPM. 2011. Solutions for a cultivated planet. *Nature* **478**: 337–342.
Frey B. 2008. *Happiness: a Revolution in Economics*. MIT Press: Cambridge, MA.
Frey B, Luechinger S, Stutzer A. 2009. The Life Satisfaction Approach to Environmental Valuation, CESIFO Working Paper 2836.
Frijters P, Haisken-DeNew JP, Shields MA. 2004. Money does matter! Evidence from increasing real income and life satisfaction in East Germany following reunification. *American Economic Review* **94**: 730–740.
Fthenakis V, Mason JE, Zweibel K. 2009. The technical, geographical, and economic feasibility for solar energy to supply the energy needs of the US. *Energy Policy* **37**: 387–399.
Grund C, Sliwka D. 2007. Reference-dependent preferences and the impact of wage increases on job satisfaction: theory and evidence. *Journal of Institutional and Theoretical Economics* **163**: 313–335.
Hagerty MR, Veenhoven R. 2003. Wealth and happiness revisited – growing national income *does* go with greater happiness. *Social Indicators Research* **64**: 1–27.
Hamilton C. 2010. *Requiem for a Species: Why we Resist the Truth about Climate Change*. Routledge: London.
Hanjra MA, Qureshi ME. 2010. Global water crisis and future food security in an era of climate change. *Food Policy* **35**: 365–377.
Hansen JE, Sato M. 2011. Paleoclimate implications for human-made climate change. In *Climate Change at the Eve of the Second Decade of the Century: Inferences from Paleoclimate and Regional Aspects: Proceedings of the Milutin Milankovitch 130th Anniversary Symposium*, Berger A, Mesinger F, Šijači D (Eds). Springer: London.
Hansen, JE, Sato M, Kharecha P, Beerling D, Masson-Delmotte V, Pagani M, Raymo M, Royer LD, Zachos C. 2008. Target atmospheric CO_2: where should humanity aim? *Open Atmospheric Science Journal* **2**: 217–231.
Haug M. 2011. Clean energy and international oil. *Oxford Review of Economic Policy* **27**: 92–116.
Helliwell JF, Huang H. 2005. How's the Job? Well-Being and Social Capital in the Workplace, NBER Working Paper 11759.
Horlings LG, Marsden TK. 2011. Towards the real green revolution? Exploring the conceptual dimensions of a new agriculture that could 'feed the world'. *Global Environmental Change* **21**: 441–452.
Hoskins JA. 2011. Health effects due to indoor air pollution. In *Survival and Sustainability*, Gökçekus H, Türker U, Moreaux JW (eds). Springer: London; 665–676.
Houser M, Heilmayr R. 2009. A Green Global Recovery? Assessing U.S. Economic Stimulus and Prospects for International Coordination, Policy Brief PB09-3. Peterson Institute for International Economics–World Resources Institute.
Howarth RB. 2003. Climate change and relative consumption. In *Society, Behavior, and Climate Change Mitigation*, Jochem E, Bouille D, Satahye J (eds). Kluwer: Dordrecht; 191–206.
Hudson R. 2005. Towards sustainable economic practices, flows and spaces: or is the necessary impossible and impossible necessary. *Sustainable Development* **13**: 239–252.
International Energy Agency (IEA). 2010. Getting the Prices Right, IEA working paper. Paris.
Jackson T. 2009. *Prosperity Without Growth*. Earthscan: London.
Jacobson MZ, Delucchi MA. 2011. Providing all global energy with wind, water, and solar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials. *Energy Policy* **39**: 1154–1169.

DOI: 10.1002/eet

Kahneman D, Deaton A. 2010. High income improves evaluation of life but not emotional well-being. *Proceedings of the National Academy of Sciences* **107**: 16 489–16 493.
Kahneman D, Tversky A. 1984. Choices, values and frames. *American Psychologist* **39**: 341–350.
Kapteyn A, Smith JP, van Soest A. 2007. Vignettes and self-reports of work disability in the United States and the Netherlands. *American Economic Review* **97**: 461–473.
Kapteyn A, Smith JP, van Soest A. 2010. Life Satisfaction, IZA Discussion Paper 4015.
Kassam A, Friedrich T, Shaxson F, Pretty J. 2009. The spread of conservation agriculture: justification, sustainability and uptake. *International Journal of Agricultural Sustainability* **7**: 292–320.
Krause F, DeCanio S, Hoerner A, Baer P. 2003. Cutting carbon emission at a profit. Part II: Impacts on U.S. competitiveness and jobs. *Contemporary Economic Policy* **21**: 90–105.
Kristensen N, Johansson E. 2008. New evidence on cross-country differences in job satisfaction using anchoring vignettes. *Labour Economics* **15**: 96–117.
Krugman P. 2008. *The Return of Depression Economics and the Crisis of 2008*. Norton: London.
Krugman P. 2009. The road to global economic recovery, 2009. *Revista de Economia del Caribe* **4**: 1–18.
Krugman P. 2012. *End this Depression Now*. Norton: London.
Küster R, Ellersdorfer IR, Fahl U. 2007. A CGE-Analysis of Energy Policies Considering Labor Market Imperfections and Technology Specifications, FEEM Working Paper 7.2007, Fondazione Eni Enrico Mattei, Milan.
Lal R. 2011. Sequestering carbon in soils of agro-ecosystems. *Food Policy* **36**: 33–39.
LaSalle T, Hepperly P. 2008. *Regenerative 21st Century Farming: a Solution to Global Warming*. Rodale Institute: Kutztown, PA.
Layard R. 2011. *Happiness*. Penguin Books: London.
Layard R, Mayraz G, Nickell S. 2010. Does relative income matter? Are the critics right? In *International Differences in Well-Being*, Diener E, Helliwell J, Kahneman D (eds). Oxford University Press: New York; 139–165.
Lenton TM, Held H, Kriegler E, Hall JW, Lucht W, Rahmstorf S, Schnellnhuber HJ. 2008. Tipping elements in the Earth's climate system. *Proceedings of the National Academy of Sciences* **105**: 1786–1793.
Li H, Liu PW, Ye M, Zhang J. 2011. Does Money Buy Happiness? Evidence from Twins in Urban China, working paper, Tsinghua University.
Luechinger S. 2009. Valuing air quality using the life satisfaction approach. *The Economic Journal* **119**: 482–515.
Luechinger S, Raschky P. 2009. Valuing flood disasters using the life satisfaction approach. *Journal of Public Economics* **93**: 620–633.
Luttmer EFP. 2005. Neighbors as negatives: relative earnings and well-being. *Quarterly Journal of Economics* **120**: 963–1002.
Mathiesen BV, Lund H, Karlsson H. 2011. 100% renewable energy systems, climate mitigation and economic growth. *Applied Energy* **88**: 488–501.
McBride M. 2001. Relative-income effects on subjective well-being in the cross-section. *Journal of Economic Behavior and Organization* **45**: 251–278.
McKibben B. 2007. *Deep Economy: the Wealth of Communities and the Durable Future*. One World: Oxford.
McMichael A, Beaglehole R. 2000. The changing global context of public health. *The Lancet* **356**: 495–499.
Michaelowa A, Michaelowa, K. 2007. Climate or development: is ODA diverted from its original purpose? *Climatic Change* **84**: 5–21.
Montgomery DR. 2008. *Dirt: the Erosion of Civilizations*. University of California Press: Berkeley, CA.
Moro M, Brereton F, Ferreira S, Clinch JP. 2008. Ranking quality of life using subjective well-being data. *Ecological Economics* **65**: 448–460.
Neumayer E. 2007. A missed opportunity: the Stern Review on climate change fails to tackle the issue of non-substitutable loss of natural capital. *Global Environmental Change* **17**: 297–301.
New Economics Foundation (NEF). 2009. *The Cuts Won't Work*. NEF: London.
Niggli U, Hepperly P, Scialabba N. 2009. *Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems*. Food and Agriculture Organization: Rome.
Nordhaus WD. 2008. *A Question of Balance; Weighing the Options of Global Warming Policies*. Yale University Press: New Haven, CT.
O'Connor FM, Boucher O, Gedney N, Jones CD, Folberth GA, Coppell R, Friedlingstein P, Collins WJ, Chappellaz J, Ridley J, Johnson CE. 2010. Possible role of wetlands, permafrost, and methane hydrates in the methane cycle under future climate change: a review. *Reviews of Geophysics* **48**: RG4005. DOI: 10.1029/2010RG000326
Ostfeld RS. 2009. Climate change and the distribution and intensity of infectious diseases. *Ecology* **90**: 903–905.
Pischke J-S. 2011. Money and Happiness: Evidence from the Industry Wage Structure, NBER Working Paper 17056.
Powdthavee N. 2008. Putting a price tag on friends, relatives, and neighbours: using surveys on life satisfaction to value social relationships. *Journal of Socio-Economics* **37**: 1459–1480.
Proto E, Sgroi D. 2009. Happiness and Productivity, IZA Working Paper 4645.
Roberts I. 2010. *The Energy Glut*. Zed: London.
Sachs J. 2011. *The Price of Civilization: Economics and Ethics After the Fall*. Bodley Head: London.
Sayre K, Govaerts B. 2011. Use of conservation agriculture to improve farming systems in developing countries. In *Rainfed Farming Systems*, Tow P, Cooper I, Partridge I, Birch C (eds). Springer: London; 861–873.
Schlenker W, Lobell DB. 2010. Robust negative impacts of climate change on African agriculture. *Environmental Research Letters* **5**: 1–8.
Schlenker W, Roberts MJ. 2008. Estimating the Impact of Climate Change on Crop Yields: the Importance of Nnonlinear Temperature Effects, NBER Working Paper 13799.
Schöb R. 2005. The double-dividend hypothesis of environmental taxes: a survey. In *The International Yearbook of Environmental and Resource Economics 2005/2006*, Folmer H, Tietenberg T (eds). Elgar: London; 223–279.
Speth G. 2008. *The Bridge at the End of the World*. Yale University Press: New Haven, CT.

DOI: 10.1002/eet

Stern N. 2008. The economics of climate change, Richard Ely Lecture. *American Economic Review: Papers and Proceedings* **98**: 2–37.
Stern N. 2009. *A Blueprint for a Safer Planet: How to Manage Climate Change and Create a New Era of Progress and Prosperity*. Bodley Head: London.
Stevenson B, Wolfers J. 2008. Economic growth and subjective well-being: reassessing the Easterlin Paradox. *Brookings Papers on Economic Activity* **Spring**: 1–87.
Stiglitz JE. 2006. *Making Globalization Work*. Norton: New York.
Stiglitz JE. 2010. *Freefall, America, Free Markets and the Sinking of the World Economy*. Norton: New York.
Stiglitz JE, Sen A, Fitoussi JP. 2010. *Mismeasuring our Lives: Why GDP Doesn't Add Up*. New: New York.
Thierfelder C, Wall PC. 2010. Investigating conservation agriculture (CA) systems in Zambia and Zimbabwe to mitigate future effects of climate change. *Journal of Crop Improvement* **24**: 113–121.
Traber T, Kemfert C. 2011. Gone with the wind? Electricity market prices and incentives to invest in thermal power plants under increasing wind energy supply. *Energy Economics* **33**: 249–256.
Travis WR. 2010. Going to extremes: propositions on the social response to severe climate change. *Climatic Change* **98**: 1–19.
Tsai M-C. 2009. Market openness, transition economies and subjective wellbeing. *Journal of Happiness Studies* **10**: 523–539.
Urry HL, Nitschke JB, Dolski I, Jackson DC, Dalton KM. Mueller CJ, Rosenkranz MA, Ryff CD, Singer BH, Davidson RJ. 2004. Making a life worth living: neutral correlates of well-being. *Psychological Science* **15**: 367–372.
van den Bergh JCJM. 2004. Optimal climate policy is a utopia: from quantitative to qualitative cost–benefit analysis. *Ecological Economics* **48**: 385–393.
van den Bergh JCJM. 2009a. Safe climate policy is affordable – 12 reasons. *Climatic Change* **101**: 339–385.
van den Bergh JCJM. 2009b. The GDP paradox. *Journal of Economic Psychology* **30**: 117–135.
Van Praag BMS, Baarsma BE. 2005. Using happiness surveys to value intangibles: the case of airport noise. *The Economic Journal* **115**: 224–246.
Venkateswarlu B, Shanker AK. 2012. Dryland agriculture: bringing resilience to crop production under changing climate. In *Crop Stress and Its Management: Perspectives and Strategies*, Venkateswarlu B, Shanker AK, Shanker C, Maheswari M (eds). Springer: London; 19–44.
Watkiss P, Hunt A, Horrocks L. 2009. *Scoping Study for a National Climate Change Risk Assessment and Adaptation Economic Analysis*. Metronomica: London.
Weiss C, Bonvillian WB. 2009. *Structuring an Energy Technology Revolution*. MIT Press: Cambridge, MA.
Weitzman M. 2007. Structural Uncertainty and the Value of Statistical Life in the Economics of Catastrophic Climate Change, NBER Working Paper 13490.
Welsch H. 2002. Preferences over prosperity and pollution: environmental valuation based on happiness surveys. *Kyklos* **55**: 473–494.
Welsch H. 2006. Environment and happiness: valuation of air pollution using life satisfaction data. *Ecological Economics* **58**: 801–813.
Wezel A, Bellon S, Doré T, Francis C, Vallod D, David C. 2009. Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development* **29**: 503–515.
Wilkinson R, Pickett K. 2009. *The Spirit Level: Why More Equal Societies Always Do Better*. Allen Lane: London.
World Health Organization (WHO). 2011. Green and Healthy Jobs in Transport: Launching a Partnership under THE PEP. WHO–United Nations Commission for Europe: Copenhagen, Denmark.
Zaferatos NC. 2011. Sustaining the ancient olive community: strategies for Mediterranean sustainable development. *Journal of Sustainable Development* **4**: 23–35.
Zimmermann A, Easterlin RA. 2006. Happily ever after? Cohabitation, marriage, divorce, and happiness in Germany. *Population and Development Review* **32**: 511–528.

DOI: 10.1002/eet